

Disparities in Water and Sewer Services in North Carolina: An Analysis of the Decision-Making Process

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In July 2010, the United Nations General Assembly passed Resolution 64/292, recognizing the human right to clean drinking water and safe sanitation.¹ The resolution called on all member states to ensure equitable access to water and sanitation. Although piped water and sewer services have been heralded as among the greatest public health achievements in 20th-century US history,² communities across the country are still fighting for equal access to this basic right. These communities rely on self-supplied, on-site wells and septic systems that serve 1 or several households and are therefore unregulated by the US Safe Drinking Water Act (Pub. L. 93-523, 88 Stat. 1660 [1974]). Previous US studies have shown that populations relying on self-supplied water and sewer systems face excess health and economic risks in comparison with populations with access to community water and sewer service. For example, whereas waterborne disease outbreaks have declined in community water systems since monitoring began in 1971, waterborne disease outbreaks for self-supplied wells have increased owing to weak standards and poor monitoring of these systems.³ Also, increased septic tank density in neighborhoods has been associated with greater risks of both bacterial and viral diarrheal illness.⁴ In addition to health concerns, well and septic system users cite stench, decreased property value, and high repair costs as adverse effects of relying on self-supplied systems.⁵

Despite the potential health and societal costs, 26% of North Carolinians rely on self-supplied water systems and 49% on septic systems, compared with national estimates of 14% and 24%, respectively.^{6,7} Although many of these people reside in rural areas where homes are widely dispersed and piped water and sewer services are impractical, some live in small, densely populated communities bordering cities and towns with centralized services.⁸⁻¹² Despite their proximity, these unincorporated communities lack not only water and sewer service but

Objectives. We examined the factors that affect access to municipal water and sewer service for unincorporated communities relying on wells and septic tanks.

Methods. Using a multisite case study design, we conducted in-depth, semi-structured interviews with 25 key informants from 3 unincorporated communities in Hoke, New Hanover, and Transylvania counties, North Carolina, July through September 2013. Interviewees included elected officials, health officials, utility providers, and community members. We coded the interviews in ATLAS.ti to identify common themes.

Results. Financing for water and sewer service emerged as the predominant factor that influenced decisions to extend these services. Improved health emerged as a minor factor, suggesting that local officials may not place a high emphasis on the health benefits of extending public water and sewer services. Awareness of failed septic systems in communities can prompt city officials to extend sewer service to these areas; however, failed systems are often underreported.

Conclusions. Understanding the health costs and benefits of water and sewer extension and integrating these findings into the local decision-making process may help address disparities in access to municipal services. (*Am J Public Health*. 2015;105:e20–e26. doi:10.2105/AJPH.2015.302731)

often also city fire and police protection, municipal voting rights, and trash collection.⁵ These disparities in public services may, in turn, contribute to disparities in public health and safety.

Understanding the factors influencing decisions to extend water and sewer service to underserved communities can provide insight into how to overcome service disparities and improve overall service quality. Little is known about how the major stakeholders and the social, political, and physical environment affect the local decision-making processes of water and sewer extension. We sought to close this knowledge gap and identify the barriers and avenues to water and sewer service extension through a series of in-depth, semi-structured interviews with key informants from 3 North Carolina communities.

METHODS

We selected 3 North Carolina cities—Brevard, Raeford, and Wilmington—and neighboring unincorporated communities to

represent different regions, population sizes, demographic characteristics, and levels of progress toward water and sewer extension (Table 1; data available as a supplement to the online version of this article at <http://www.ajph.org>). All the unincorporated communities lack centralized water, centralized sewer, or both and are located within a mile of a city. The communities neighboring Raeford and Brevard share a border with these towns.

The Transylvania County Health Department has recognized the unincorporated community neighboring Brevard, the first case study site, as a priority for sewer extension. The city of Brevard has expressed interest in partnering with the county to extend water and sewer services (Hamilton T. Joint City and County Planning Board Meeting). By contrast, Raeford has not made any clear steps to extend sewer services to the neighboring unincorporated community in which we conducted the second case study. In Wilmington, the New Hanover County and the Cape Fear Public Utility Authority voted in 2013 to extend water and sewer

TABLE 1—Demographic Characteristics of Case Study Locations: Hoke, New Hanover, and Transylvania Counties, NC, 2013

Characteristic	Case Study Site 1 (Transylvania County)		Case Study Site 2 (Hoke County)		Case Study Site 3 (New Hanover County)	
	Unincorporated Community 1	Neighboring Town (Brevard)	Unincorporated Community 2	Neighboring Town (Raeford)	Unincorporated Community 3	Neighboring Town (Wilmington)
Geographic region	Mountains		Piedmont		Coast	
Population, no.	122	7 609	208	4 611	280	106 476
Median age, y	37	47	42	39	48	35
% White	99.2	83.3	17.8	43.6	89.3	73.5
Median household income, \$	NA ^a	37 262	NA	30 235	NA	38 900
Access to centralized services	Lacks sewer; has community water service		Lacks sewer; has community water service		Lacks sewer and community water service ^b	

Note. NA = Not applicable.

Source. 2010 US Census Bureau.¹³

^aMedian household income data are not publicly available at the census block level, which is the level necessary to characterize income levels in the case study unincorporated communities.

^bConstruction to extend both water and sewer lines began in August 2014 and is expected to be completed by December 2015 (Heritage Park Area Pre-Construction Information Meeting, 2014).

service to the unincorporated neighborhood included as the third case study, and construction began in August 2014 (Heritage Park Area Pre-Construction Information Meeting, 2014; Cape Fear Public Utility Authority, Engineering, Project Management Division, 2014).

To understand the processes influencing decisions about whether to extend water and sewer services, we recruited key stakeholders affected by or involved in decision-making from each community: 9 from Transylvania County and 8 from each of the other 2 sites (data available as a supplement to the online version of this article at <http://www.ajph.org>). We interviewed 7 utility providers, 6 community members, 4 elected officials, 4 health officials, 2 city or county managers, and 2 zoning officials. Of the 25 interview participants, 22 participants (88%) were White and the remaining 3 participants were Black. Seventeen participants (68%) were male. We did not collect age information, but all participants were working-age adults. We identified potential interviewees through newspaper articles, government Web sites, and recommendations from other recruited participants. We conducted 23 in-depth semistructured interviews of 30 to 100 minutes each in person (n = 19) or by phone (n = 4) with 25 key informants from July through September 2013. We audio recorded and transcribed interviews, excluding 1 owing to the participant's refusal to

be recorded. In this case, we used detailed notes in place of the recording.

We first read the transcribed interviews in full to identify recurring factors influencing decisions on the extension of water and sewer services. We assigned each of the factors to codes once we identified them, which 3 researchers then used to mark relevant sections of text. These sections were usually several sentences in length, and researchers considered the text's surrounding context to ensure that the selection accurately reflected the meaning of the chosen code or codes. At the beginning of the coding process, all 3 researchers independently coded the same 3 transcripts and compared results to establish intercoder reliability. All the coders shared additional codes that emerged during subsequent readings, and they incorporated the codes into the codebook. Finally, the researchers used the coded selections in ATLAS.ti version 7.5.6 (ATLAS.ti GmbH, Berlin, Germany) to analyze the frequency at which each factor influencing service extension was discussed in the transcripts.

RESULTS

Interviewees identified 18 factors influencing water and sewer extension, and we grouped these factors into 5 overarching themes: financing, government support,

existing infrastructure, community engagement, and public health (Table 2). For each factor, we analyzed the number of interviews that mentioned the factor (Figure 1) and the frequency with which the factors were mentioned in all the interviews (Figure 2). In both of these representations, the monetary costs and benefits of extension emerged as the leading factors. The location and capacity of existing water and sewer infrastructure and the extent of community organization to advocate service extensions also emerged as leading factors in both representations. Surprisingly, health risks associated with reliance of on-site water and sewer systems were mentioned infrequently.

Financing

All participants referred to the high cost of water and sewer extension, but there were differing opinions on whether the benefits of extension could outweigh these costs. One of the benefits from the city's perspective was the potential for economic development. The majority of participants (n = 20) believed that extending water and sewer infrastructure would draw new businesses, create jobs, and boost the local economy, as illustrated by the following quotation:

Gold runs through those utility lines. You don't recognize that, but it's gold, economic gold. (mayor)

TABLE 2—Factors Influencing Decisions to Extend Water and Sewer Services: Hoke, New Hanover, Transylvania Counties, NC, 2013

Factors	Definitions
Financing	
Local priorities	Extent to which funding for water and sewer service is a city or county priority compared with other rivaling priorities
Perceived economic development benefits of extensions	Extent to which water and sewer extensions are seen as benefiting the city or county economy indirectly (e.g., the extension encourages new businesses to settle)
Availability of outside funding	Availability of grants and loans to fund water and sewer extensions
Costs and benefits of extensions	Direct monetary costs and benefits of water and sewer extension (e.g., revenue from new customers)
Government support	
Annexation for service extension	How annexation into the city plays a role in the extension of water and sewer
Decision-makers	The governmental and nongovernmental actors that must be involved to extend services and their roles
Government involvement in unincorporated communities	Extent to which government officials are involved in addressing the unincorporated community's needs
Planning and zoning laws	Planning and zoning laws and considerations that influence water and sewer extension (e.g., long-range planning for economic growth that calls for service extension)
Relationships among government departments	How the interactions between various government actors affect the decision-making process (e.g., a strained relationship between county and city officials can affect the shared decision to extend city services beyond city limits)
Existing Infrastructure	
Well and septic tank permitting rules	Extent to which the rules governing well and septic tank permitting affect their repairs and replacements
Environmental factors affecting pipe network construction	Impact of environmental factors (e.g., topography, rainfall) on the costs of extending water and sewer infrastructure
Piped water and sewer infrastructure location and capacity	Capacity, location, and ownership of existing piped water and sewer infrastructure
Problems associated with septic tank use	Financial and societal challenges for the homeowner owing to septic tank use
Community engagement	
Community involvement	Extent to which the unserved community has organized and advocated for service extensions
Presence of renters in unincorporated areas	How the presence of renters in unincorporated communities affects extension
Public health	
Availability of data on septic tank failure rates	Extent to which failure rates of septic systems and other potential health risk factors are monitored
Awareness of health risks	Extent to which decision-makers are aware of health risks associated with domestic water and sewer systems
Availability of data on water contamination from septic tanks	Whether contamination of water and soil owing to failed septic tanks is known to be present in the community

A second potential economic benefit was the addition of new taxpayers if the unincorporated community were to be annexed into the city or town as part of extending municipal services. Two of the 3 cities in this study, Brevard and Raeford, required that communities be annexed before extending services. However, participants suggested that the new tax receipts may not be enough to cover the high costs, as one interview participant explained:

We've got a section in town here that does want to be annexed. The [city] will not do it. We did a study on it The payback was like 115 years. (mayor)

Considering the limited benefits compared with the costs of expansion, grants and, to a lesser extent, low-interest loans were the most desired funding options. One participant observed:

Grants go a long way to easing political negotiations. (utility provider)

Nevertheless, there were barriers to this type of funding that included lack of availability, lengthy applications requiring extensive data, and the cooperation of city or county governments as the grant applicant, as one participant commented:

That takes grant writing, tests being done, getting environmental people even at the state level involved, and to produce all that data so you could put it in your grant. (county commissioner)

Government Support

In all 3 cities, city and county government officials were intricately tied to the decision-making process for centralized water and sewer extension. Nevertheless, there were challenges to successful and cohesive government involvement owing to the high costs of extension and the many

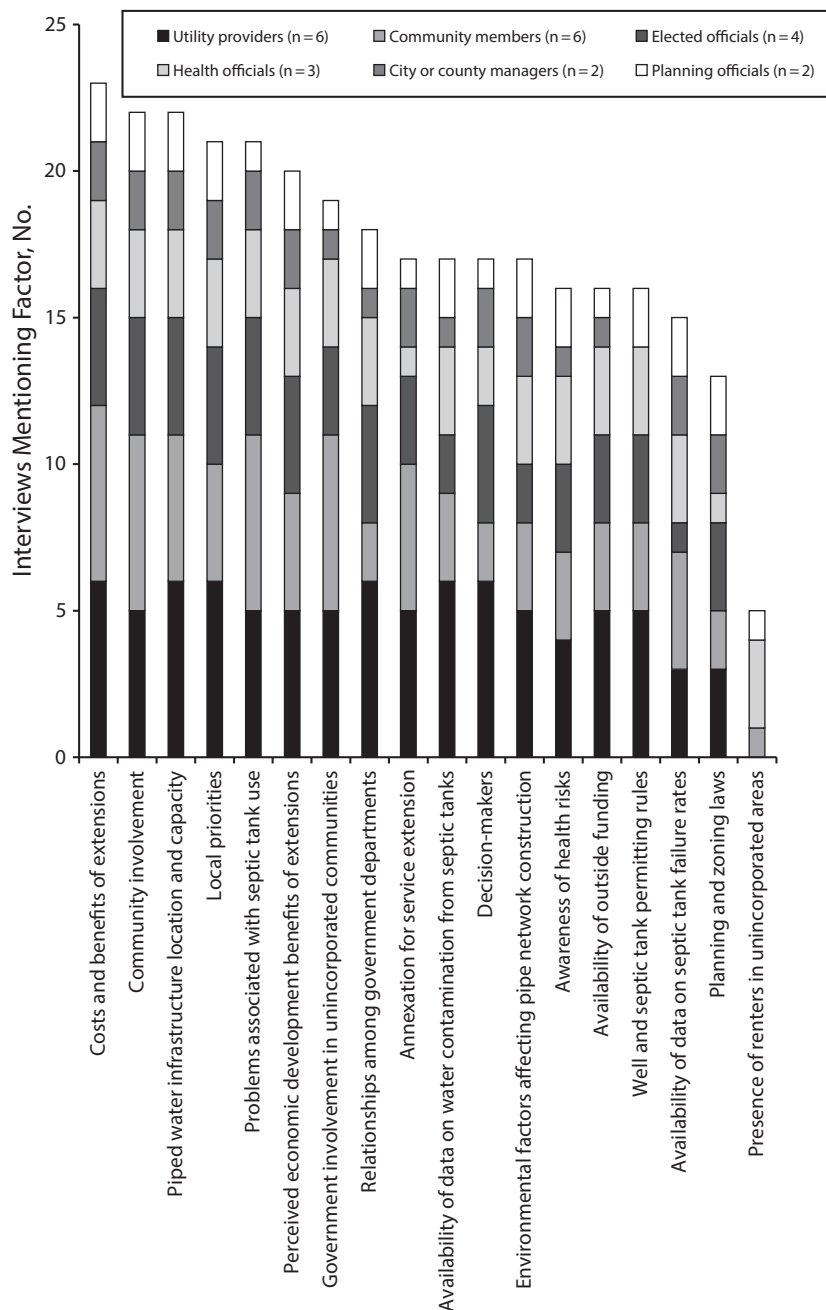


FIGURE 1—Factors influencing decisions to extend water and sewer service, by the number of interviews in which they are mentioned: Brevard, Raeford, and Wilmington, NC, 2013.

people involved, as the following quotations illustrate:

Sewer is very, very expensive to run so when you get into a lot of money, sometimes you get into a lot of politics. (health official)

[Service extension] is daunting . . . there's too many people that have to come together. (utility provider)

The potential for political conflict was evident from the interviews as the actors shared their different roles and priorities. The key players who emerged from the interviews were health officials, who monitor private system use and have an obligation to protect public health; utility providers, who manage the physical

extension and delivery of services and have a responsibility to balance the costs and benefits of service extensions; and elected commissioners and mayors, who must address the needs and interests of the electing body and hold the ultimate decision-making power. In addition to varying perspectives stemming from these actors' positions, the interviews also revealed a division of interests between government factions: county officials versus city officials and unelected staff members versus elected officials, as the following quotations illustrate:

They have to do that really from a strong cost-benefit analysis, which is my interpretation. And that leads to a model that doesn't always support the interest of public health. (health official)

I think sometimes [city and county officials] build a wall up and they say, "This is my responsibility and on that side of the wall is your responsibility." Who gets caught in the middle is the average resident. (mayor)

Coordination of all these actors representing cities, counties, staff positions, elected positions, and various departments is essential to extending services; however, their different roles, perspectives, and priorities can make the process difficult and lengthy:

[Extension projects] don't take months or a year. They always take years, because the engineering and the construction is easy. It's straightforward. It's the relationship[s] [that are difficult]. It's the intergovernmental relationship. (utility provider)

Existing Infrastructure

In all 3 unincorporated communities, septic tank maintenance and repair were cited as major problems for homeowners and yet were also potential motivating factors for extending sewer services when decision-makers were made aware of septic failures. One health official discussed some of the challenges associated with failing septic infrastructure:

If we have failures, of course you're going to have sewerage on top of the ground. . . . I've seen it run down the street and people will ride their bicycles through it. . . . children have little toys in it . . . so that's the big risk, is just transmission of disease from the raw sewerage. (health official)

Despite the health risks associated with failing septic systems, homeowners are often unwilling to request permits to repair or replace their systems, in part owing to high costs. Shifting standards for septic tank permitting have further exacerbated the repair and

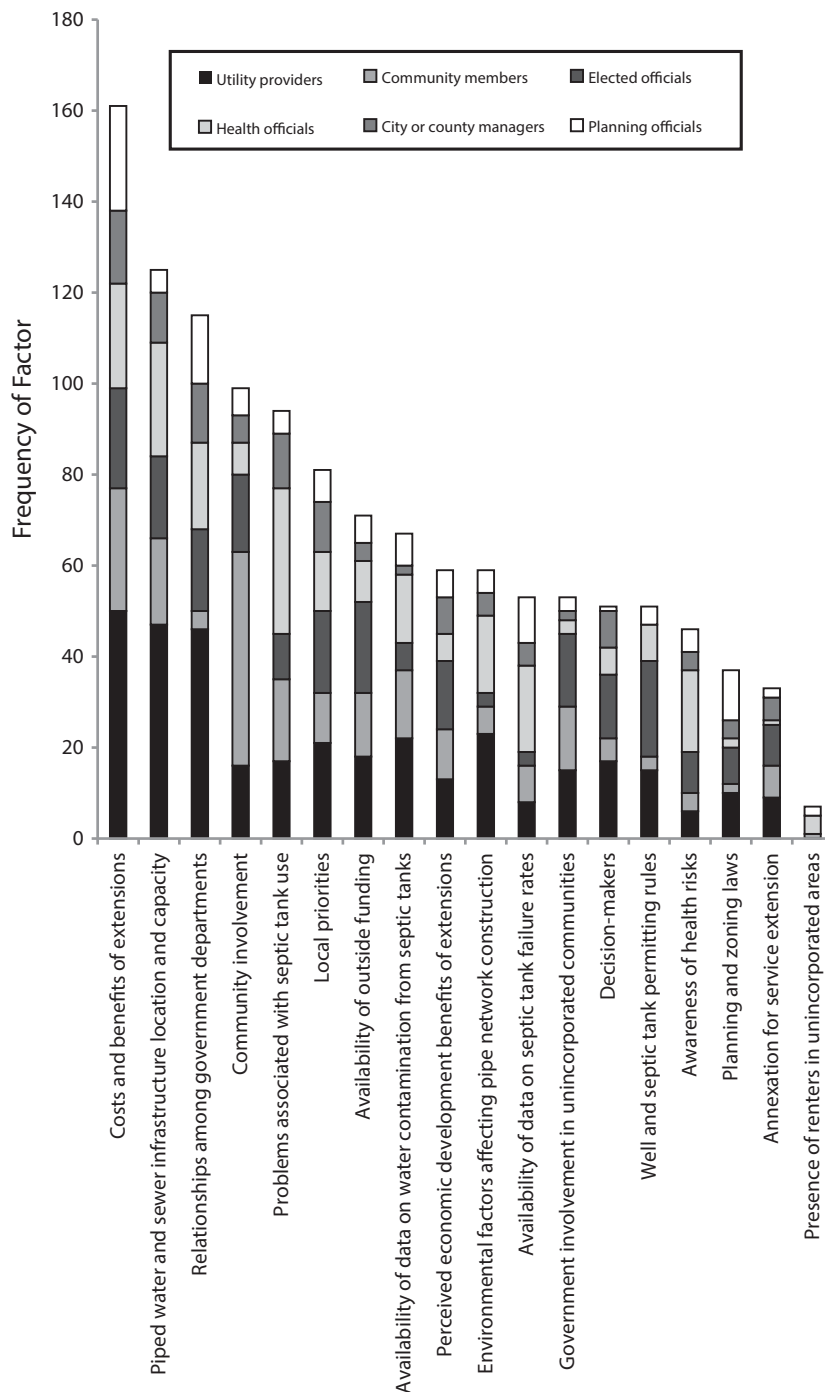


FIGURE 2—Factors influencing decisions to extend water and sewer service, by the frequency mentioned across all interviews: Brevard, Raeford, and Wilmington, NC, 2013.

replacement costs. Systems that met the standards in place at the time of installation (often a half century ago or more) may not meet modern regulations. Homeowners struggle to

maintain compliance as a result of increasingly stringent permitting standards.

From the community's perspective, failing septic systems were a burden both financially

and otherwise. From the government's perspective, though, extensive septic system failures were cited as a primary driver for water and sewer service extension. Government officials expressed a greater willingness to extend services when the neighborhood experienced high levels of septic failures, as one commissioner indicated:

Not only had the septic lines, the original ones, failed, the repair lines had failed. . . . I don't think the city in any other situation would extend their sewer services. (county commissioner)

In addition to high prevalence of septic tank failures, another driver for extension from the utility's perspective was the opportunity to gain new customers. Utilities with a storage or treatment capacity that far exceeded their customer base were especially eager for additional customers to use their existing infrastructure.

Community Engagement

A fourth theme was the impact of the unincorporated communities on water and sewer extension. Although the government holds much of the power in the decision-making process, communities can play a role in raising awareness and pressuring the government to act, as one utility provider acknowledged:

[Awareness] mainly comes from citizens approaching the commissioners with their concerns. (utility provider)

Communities can more effectively persuade local leaders through unified and organized efforts as opposed to individual complaints, as the following participant observed:

They really need to organize and come forward as a group and request support from the city and they have never done that; it has always been one or 2 individuals. (planning manager)

One challenge to community involvement was disagreements within communities between those desiring municipal services and those preferring wells and septic tanks. For homeowners experiencing failed septic systems or wells, centralized water and sewer may be the desired solution; however, others may be unwilling to incur the fees of extension. This is especially true for renters, who do not benefit from the potential increase in home value and instead may have to pay higher rent.

Considering the differences in level of need and desire for centralized service in the unincorporated communities, unified efforts to persuade government officials to extend services can be difficult to organize.

Public Health

Health officials in all 3 counties discussed the possible health risks of failing septic systems, including disease transmission through surface water contamination, well contamination, and direct contact with fecal waste. Nonetheless, among other factors mentioned, the potential health benefits of water and sewer extension did not emerge as a leading concern. Only in Wilmington did decision-makers link these potential risks to their unincorporated community.

One of the challenges with assessing health risks was the lack of a robust monitoring system for septic tank failures. Health departments rely mainly on homeowners or complaining neighbors self-reporting to identify failures. One health director said 90% of their awareness of failing septic systems comes from either septic tank owners' or neighbors' reports. This complaint-based method can lead to under-reporting and inaccurate data. Homeowners fearing the consequences of a failed septic tank, including high repair costs or even home condemnation, may be reluctant to inform health officials of any problems, as the following quotations illustrate:

They've been misled by their friends or family members and they'll tell them not to call the health department because [the repair's] going to cost them 10 thousand dollars. (health official)

[The health department] would not come in to help; they would condemn your house. (community member)

The health department may also avoid exposing failed septic systems in an effort to protect their constituents, especially those of lower socioeconomic level, from home condemnation as one community member suggested:

They had a gentleman from the health department come around and they know that some of the septic tanks are really bad but they're turning a blind eye and trying not to condemn any homes. (community member)

Poor monitoring by the health department and self-reporting by homeowners call into question the accuracy of data on septic tank

failures under the prevailing monitoring system. Some health officials recognized that failed septic tanks are falling through the cracks:

There are a lot of [septic tanks] that are failing now that we don't know about, and people just live with them. (health official)

New Hanover County officials recognized the need for accurate, unbiased septic tank performance data. This county moved beyond the complaint-based monitoring system and collected data by door-to-door anonymous surveying on septic tank failures and water quality monitoring of rivers neighboring areas with high septic tank use. The data gathered through these methods allowed county health officials to present a strong argument and ultimately persuade county commissioners to approve service extension. One county official noted:

I think the health director saying this is a community health hazard . . . that means you've got to take care of it. . . . That ended the argument. (county official)

DISCUSSION

The predominant theme influencing access to water and sewer service for all 3 case studies was financing for extension. Lack of sufficient financing was mentioned in all 23 interviews. Conversely, whereas health officials frequently cite the health risks associated with private water and sewer use, public health appeared to have influenced decision-making in only 1 (New Hanover) of the 3 counties studied, in part owing to a lack of information in the other communities. In Hoke and Transylvania counties, there appeared to be a perception gap between public health officials, who were aware of the health impacts of substandard water and sewer service, and other stakeholders, who often did not cite these as a factor for extension. As the New Hanover case illustrates, evidence of extensive septic system failures can help overcome this perception gap and catalyze decisions to extend infrastructure to unincorporated communities. However, data on the extent of such failures often are not available owing to the lack of a systematic monitoring process.

Consistent with our finding that the perceived costs and benefits of service extensions have

an influence on decision-making, Altschuler et al. found that a community's socioeconomic level affects how quickly and successfully the government responds to community needs.¹³ Altschuler et al. attributed this tendency partly to government officials' perceived benefits of serving higher-income communities, including the potential for larger campaign donations and a greater showing at the polls.¹⁴ Similarly, the benefits of extending services emerged as an important consideration for decision-makers. Understanding what the city or county would gain from extending services—such as new taxpayers and utility customers, economic development, and improved community health—was critical to the decision-making process. Considering the importance of tangible benefits to the decision-making process both in our study and in the literature, efforts to alleviate disparities in access to water and sewer should include a detailed exploration and presentation of the major benefits of extension to decision-makers.

Previous public health research has emphasized health risks as the primary rationale for recommending the extension of water and sewer services to undeserved communities. Heaney et al. linked fecal contamination of surface waters and drinking water supplies to areas of high septic tank failure,¹⁰ and Uhlmann et al. found a higher risk of enteric disease for individuals serviced by private wells.¹⁵ Both studies indicated that use of municipal water and sewer systems over self-supplied systems may alleviate these risks.^{10,15}

Despite an emphasis on the health effects of water and sewer access in past studies, we found an apparent lack of awareness of these risks in 2 of the 3 communities. Nevertheless, risky health situations were described in all 3 counties, including septic tank overflows into yards, streets, and nearby creeks, all of which can increase risks of infectious disease transmission.

Studies have linked disparities in access to water and sewer service in the American South to historical and present acts of racism. As an example, demographer Charles Aitken in 1987 documented a phenomenon in Mississippi's Yazoo Delta in which "some towns and cities . . . have selectively expanded the corporate boundaries to exclude Blacks," calling this phenomenon "municipal underbonding."¹⁶

More recently, such underbounding of Black communities and the resulting lack of water or sewer services was documented in 4 North Carolina communities (Alamance, Moore, Orange, and Wake counties).^{11,12,17–19} We found that the Hoke County community has a distinct racial difference from the neighboring city, and it is possible that race may have played a role in the zoning patterns that led to the exclusion of this community from sewer services.

However, race was not the only potential factor that emerged from these findings. In the other 2 communities we studied, both of which were predominantly White, age and socioeconomic level emerged as relevant factors. Several interviewees indicated that the community residents in Transylvania County were at a lower socioeconomic level than was the population in Brevard. Furthermore, the community residents in New Hanover County were older than were those in Wilmington (Table 1). Consistent with previous studies linking age and socioeconomic level to limited political power,^{9,20} these results indicate that race, socioeconomic level, and age may all serve as important potential factors influencing disparities in access to water and sewer service.

Limitations

One limitation of this study was the potential for bias in the responses. Because of the sensitive nature of the topic, it is possible that participants withheld information or volunteered untrue information to protect their own reputation or that of their city, particularly in areas with considerable media attention on inequitable access to water and sewer service. To put respondents at ease and protect against potential bias, the interviewer assured respondents that no identifying information would be used in the data analysis or presentation.

A second limitation was the use of code frequency to rank the key themes. The frequency with which these themes were mentioned in the interviews does not necessarily reflect the level of importance placed on the themes. To address this limitation, we performed an additional close reading of the interview transcripts to ensure that the frequency with which themes were coded accurately portrayed the weight they were given in the transcripts.

Conclusions

Unequal access to water and sewer services can have considerable health effects^{3,10,15} and disproportionately burdens the politically vulnerable.^{9,20} Understanding the key factors affecting service extension can be useful to stakeholders involved in the decision-making process. Our study indicates the need for improved mechanisms that extend beyond self-reporting to assess the risks of septic tank failures and other health concerns associated with on-site water and sewer systems. Future research should further quantify the health risks associated with disproportionate access to water and sewer services as this was often overlooked in the decision-making process, despite its potential influence. ■

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Contributors

J. M. Naman conceptualized the study, conducted the interviews, analyzed the data, and led the writing. J. M. Gibson conceptualized the research project on disparities in water and sewer service access, of which this study is a component, and contributed to the writing, reviewing, and editing of the article.

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Human Participant Protection

The institutional review board of the University of North Carolina, Chapel Hill approved this study.

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